

## QUANTUM ROD AND METHOD OF FABRICATING THE SAME

The present application claims priority to and is a divisional application of U.S. patent application Ser. No. 14/085,073, filed on Nov. 20, 2013, which claims the benefit of Korean Patent Application Nos. 10-2012-0133815 and 10-2012-0135162, filed in Korea on Nov. 23, 2012 and Nov. 27, 2012, which are hereby incorporated by reference for all purposes as if fully set forth herein.

### BACKGROUND

#### Field of the Disclosure

The present disclosure relates to a quantum rod, and more particularly, to a liquid crystal display device having light weight, a quantum rod and a method of fabricating the same.

#### Discussion of the Prior Art

Generally, chemical and physical properties of solid crystal do not relate size of crystal. However, when size of solid crystal is several nanometers, such the size may be a variable that influences crystalline chemical and physical properties. Research of forming nanocrystal or quantum dot as a semiconductor material out of nano technologies that use distinctive properties of particles having such the nano size have been actively progressing.

Particularly, the prior inorganic light emission element, which is a semiconductor used as a light emission layer formed in thin film type with a chemical vapor deposition (CVD), has the disadvantage of low efficiency of electrical to optical conversion. There is an increasing interest on high efficient light emission elements using nano materials. Among the elements, a quantum dot of several nanometer size has a distinctive behavior of quantum effect and is known to be used for a semiconductor structure to produce a high efficient illumination element, an illuminated signs for in vivo molecules, and etc.

A quantum dot, and a quantum rod, which has a rod shape by crystal growth of a hexagonal structure as a crystalline structure is grown in one direction emit different lights according to sizes thereof.

Generally, since wavelength of light produced is shorter as size of the particle is smaller and wavelength of light produced is longer as size of the particle is greater, sizes of the quantum dot and the quantum rod are required to be appropriately adjusted.

However, since the quantum dot and the quantum rod have very small size, surface-volume ratio is very great, and atoms located on the surface have very high reactivity thus is prone to contact with grow into greater particle by contacting particle therearound.

To prevent this, a precipitation method, pyrolysis method, vapor phase growth, template synthesis, and etc. are suggested, and initial compound quantum dot and quantum rod consist of II-VI, III-V, or IV-VI group single semiconductor particle (e.g., CdSe, CdS, GaAs, GaP, GaAs—P, Ga—Sb, InAs, InP, InSb, AlAs, ALP, AlSbCuInSe<sub>2</sub>, CuInS<sub>2</sub>, AgInS<sub>2</sub>, PbS, PbSe, or PbTe).

Research of the quantum dot is made on a principle basis of changing structure of nano crystal, such as size, surface and etc. of nano crystal, in the nanometer region, thus changing property of crystal i.e., changing band gap.

The quantum dot has different illumination ranges, illumination efficiencies, chemical stability and etc. according to compositions thereof, and thus application range and application method are limited.

Particularly, the quantum rod having high efficient illumination property and polarization property as well has illumination efficiency much less than the quantum dot.

This is because the quantum rod has a rod shape differently from the quantum dot of spherical shape, thus a shell of length is greater than Bohr radius of exciton, and thus quantum confinement effect is reduced.

Accordingly, research having high efficient illumination property and polarization property is required.

Moreover, single-layered quantum dot and quantum rod are very unstable because a cationic surface or anionic surface is protected from the outside, and by capping it with other type semiconductor, a stable quantum rod can be formed.

When the quantum rod of such the core/shell structure is formed, size of band gap is freely adjusted, and the quantum rod of core/shell structure can be categorized into I type and II type.

In the I type core/shell structure, for example, when a material of small band gap is placed and formed at a core and a material of big band gap is placed and formed at a shell, a quantum well is produced between the core and the shell, and the core is capped with the shell, and thus it is more stable than a single-material quantum rod.

Further, since electrons are spread all over the quantum rod, holes are confined to the core, photooxidation due to hole-surface recombination is prevented and thus stable illumination property is obtained.

In other words, the quantum dot of the I type core/shell structure is a quantum dot having a shell that is formed on a surface of a core and has a band gap greater than that of the core, and the shell on the surface of the core has the band gap based on a valence band of lower energy than that of the core and has a conduction band of higher energy than that of the core.

In the II type core/shell structure, when the core and shell are formed of materials having different band gap offsets, holes and electrons are confined to the core and shell, respectively, and thus light corresponding to difference between band gap offsets of the two material is emitted.

When a quantum rod having such the core/shell structure is formed, lights in various colors are emitted according to combination of core/shell, for example, the quantum rod of core/shell structure includes semiconductor particles such as CdSe/CdS, ZnSe/CdS, CdTe/CdSe and CdSe/CdTe.

The quantum dot has different illumination ranges, illumination efficiencies, chemical stability and etc. according to compositions thereof, and thus application range and application method are limited.

Particularly, the quantum rod having high efficient illumination property and polarization property as well has illumination efficiency much less than the quantum dot.

This is because the quantum rod has a core or shell surrounding the core that has a rod shape differently from the quantum dot of spherical shape, thus a shell of length is greater than Bohr radius of exciton, and thus quantum confinement effect is reduced.

The quantum rod is formed in a crystalline structure of hexagonal, wurtzite, or zincblende structure, and such the structure is well formed of for example, semiconductor particle of CdS.

Accordingly, it is preferred that the quantum rod of core/shell structure is formed to include CdS, in case that CdSe and ZnSe is used for the core and CdS is used for the shell, the quantum rod only produces a color region from yellow to red (i.e., from 510 nm to 780 nm).